



Contents lists available at ScienceDirect

Journal of Forensic and Legal Medicine

journal homepage: www.elsevier.com/locate/jflm



Original communication

Forensic epidemiology of childhood deaths in Nebraska, USA

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ARTICLE INFO

Article history:

Received 2 March 2011

Received in revised form

14 June 2011

Accepted 20 July 2011

Available online 27 August 2011

Keywords:

Childhood death investigation

Childhood deaths

Forensic science

Forensic medicine

Forensic pathology

Causes of death

Manners of death

ABSTRACT

In a 7-year period (April 1, 2003–March 31, 2010), all medico-legal childhood deaths aged 0–18 years investigated by the Lancaster County Coroner's Office under the auspices of Nebraska Institute of Forensic Sciences, Inc. (NIFS), were retrospectively reviewed ($n = 140$). This number of cases represents 10.9% of the 1287 forensic autopsies performed during the same period. Age, race, gender, cause and manner of deaths were analyzed for all victims categorized into five age groups: 0–1 year, 1–4 years, 5–9 years, 10–14 years, and 15–18 years. Male victims predominated with 98 cases (70%) versus 42 cases (30%) for females giving a male to female ratio of 2.3: 1. The mean age of the children was 7.6 years. The racial composition was 86.4% white, 10.7% Hispanic, 0.7% American Indian, 1.4% African American, and 0.7% Asian American. The majority of deaths occurred in the 0–1 age group (50 cases), followed in rank order by the 15–18 age group (40 cases), the 1–4 age group (23 cases), the 10–14 age group (17 cases), and the 5–9 age group (10 cases). The most common manner of death was accident, followed by natural, suicide, homicide, and undetermined. Accidents accounted for 71 cases (50.7%) of all the deaths and are amenable to prevention. Accidental blunt force trauma accounted for 41 cases or 58% of all the accident cases. The share of motor vehicle crashes in total blunt force trauma deaths was 33 cases. Natural deaths comprised 42 cases or 30% of all the deaths. Suicide (19 cases or 13.6% of all the deaths) was only encountered in the older age groups, the 10–14 age group (6 cases) and the 15–18 age group (13 cases). However, homicide which was observed as the least common manner of death (7 cases) was more predominant among the younger age groups (0–1 and 1–4 age groups). This review may provide useful information for the forensic pathologist, death investigators, law enforcement officers, policy makers, healthcare providers and Nebraska Child Death Review Team in predicting, preventing and investigating childhood medico-legal deaths.

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1. Introduction

The Children's Bill of Rights recognized childhood as the period of life from birth until the age of 18, and stipulates that children should receive special care and protection.¹ It is well recognized that children are the future of societies, succeeding the present generation into the future. Report by Healthy People regarding the health of children indicated that infant mortality is an important measure of a nation's health and a worldwide indicator of health status and social well-being.² The death of a child, therefore, is not merely a public health problem, it is also a social tragedy. In the context of these concerns, studies that lead to a better understanding of the epidemiological patterns and characteristics of childhood deaths are very important for assisting the forensic pathologist, death investigators, the law enforcement, policy makers and Nebraska Child Death Review Team in predicting, preventing and investigating childhood medico-legal deaths.

Trauma is one of the leading etiological factors responsible for death in children.³ Of significant importance is the fact that many, if not most child injury deaths can be prevented.⁴ Naturally, the death of a loved child is a devastating experience for any family, especially if the death was unexpected. Such families rely on a thorough medico-legal investigative process for accurate explanation of why and how death occurred.

2. Cause and manner of childhood deaths

Cause of death refers to injury or disease resulting in the death, for example drowning, blunt force trauma, hanging, gunshot wound, and sudden infant death syndrome (SIDS). Manner of death explains how the death came about. Manner of death is categorized as natural, accident, homicide, suicide, or undetermined.

3. Materials and methods

A 7-year retrospective study (April 1, 2003 to March 31, 2010) was conducted in a County Coroner's office under the auspices of

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Nebraska Institute of Forensic Sciences, Inc. (NIFS) in Lincoln, Nebraska, USA to examine a total of 140 forensic childhood deaths. All forensic cases under the age of 18 were identified by review of the autopsy log of all cases referred to the County Coroner's office over the defined time period. The cases were referred from Lancaster County and other neighboring county districts in Nebraska.

The number of childhood deaths identified for this review represents 10.9% of the 1287 forensic autopsies performed during this study period. Data was evaluated with respect to the following: age (categorized into five groups: 0–1 year, 1–4 years, 5–9 years, 10–14 years, and 15–18 years), gender, sex, cause of death and manner of death. All the forensic autopsies were performed in the morgue department by the Lancaster County's forensic pathologist/medical examiner. The forensic autopsy investigations usually included a case history and investigation, gross examination, a 3-dimensional C-T Scan, histopathological and toxicological examinations. If the cause of death for a case remained undetermined after the forensic expert consultation and evaluation, the autopsy report would be ruled as undetermined. Two cases were eliminated from the study. One case was ruled as undetermined. The other case failed to meet the criteria for the study. Data was analyzed using Microsoft Excel program. Statistical analyses were made with frequencies and percentages.

4. Results

All medico-legal autopsies performed in children aged 0–18 years ($n = 140$) at the Lancaster County Coroner's Office under the auspices of Nebraska Institute of Forensic Sciences, Inc. (NIFS), in Lincoln, Nebraska, USA from April 1, 2003 to March 31, 2010 were retrospectively reviewed. This represents 10.9% of the 1,287 forensic autopsies performed during the same period. The mean age of the children was 7.6 years. Among the childhood deaths, 121 (86.4%) were whites, followed in rank order by Hispanics 15 (10.7%), African Americans 2 (1.4%), American Indian 1 (0.7%), and Asian American 1 (0.7%) (Fig. 1).

Examination of the childhood deaths in this study ($n = 140$) revealed that male victims outnumbered female victims, by 98 (70%) to 42 (30%) (Fig. 2) showing a male to female ratio of 2.3: 1. This male predominance was evident across all age groups, especially in the 1–4 age group with 83% males compared to 17% females (Table 1 & Fig. 3). Majority of the deaths occurred in the 0–1 age group (50 cases), followed by the 15–18 age group (40 cases), the 1–4 age group (23 cases), the 10–14 age group (17 cases), and lastly, the 5–9 age group (10 cases).

Cause and manner of death for all the child victims were evaluated (Table 2 & Fig. 4). Overall, accidents comprised 71 cases (50.7%) of all the deaths. Motor vehicle crashes comprised 33 cases (23.6%) of all the deaths, accounting for 73% of all blunt force traumas both accidental and non-accidental. Natural deaths (SIDS, stillbirths and prematurity, and medical/disease related deaths)

Distribution of Childhood Cases According to Gender

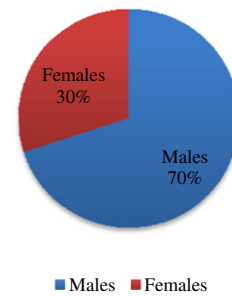


Fig. 2. Distribution of all child death cases according to gender.

comprised 42 (30%) of all the deaths. Suicide accounted for 19 (13.6%) of all the deaths. Homicide accounted for 7 (5%) of all the deaths, and 1 (7%) of the deaths was undetermined.

Overall, accident was the most predominant manner of death, followed by natural, suicide, and then homicide.

Next, manners of deaths were compared between age groups (Table 3). Results showed that accident consistently remained the most predominant manner of death for all age groups. Initially, the newborn and infants in the 0–1 age group were more prone to natural deaths than accident (54% natural compared to 36% accident). However, the rate of accident suddenly rose to 65% in the toddler and playing age group (1–4 years), and was observed to be gradually declining to 60% in the 5–9 age group, but then stayed elevated at a plateau level of 56% for both the 10–14 and 15–18 age groups. Natural deaths by comparison showed a decreasing trend overall.

Accidental blunt force trauma comprised a total of 41 deaths and the major cause of all accidental deaths (Table 2). The share of motor vehicle crashes (33) within total blunt force (intentional and unintentional) injury deaths was 73% (Table 2). Of the 33 motor vehicle-related deaths, the 15–18 age group alone comprised 18 (55%) of the deaths (Table 4), amounting to over half of the total traffic-related deaths in all age groups. Other accidental blunt force injury deaths resulted from falls from height (4), being hit by falling wall (1), stillbirths due to motor vehicle crashes (2), and breech traumatic delivery death (1). The rest of the accidental fatalities involved: stillborn with umbilical cord around the neck (1), house fire deaths (3), fatal gunshot wounds (4), and electrocution death (1).

The next major component of accidental deaths in this study was asphyxia (Tables 2 & 4) and was mostly observed among children younger than 5 years, with the 0–1 age group most vulnerable. Asphyxia deaths comprised of crib cord hanging (1 case), asphyxia by overlaying (4 cases), asphyxia by aspiration (1 case), asphyxia by suffocation (8 cases), and mechanical asphyxia due to drowning (7 cases). All of the asphyxia deaths in this study were accidental.

Following accident, the second most predominant manner of death was natural (42 cases or 30% of the total deaths). Natural

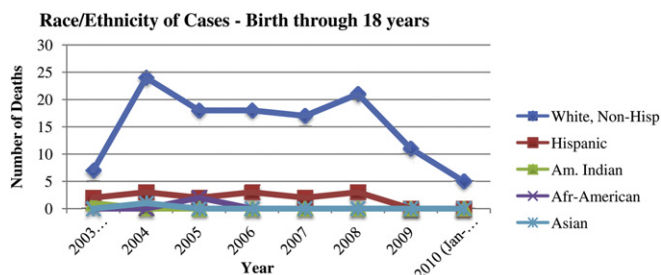


Fig. 1. Race & ethnicity of cases – birth through 18 years.

Table 1

Gender in relation to age groups.

Gender	Age groups					Total
	0–1 Year	1–4 Years	5–9 Years	10–14 Years	15–18 Years	
Male	31 (62%)	19 (83%)	6 (60%)	13 (76%)	29 (73%)	98
Female	19 (38%)	4 (17%)	4 (40%)	4 (24%)	11 (27%)	42
Total	50 (100%)	23 (100%)	10 (100%)	17 (100%)	40 (100%)	140

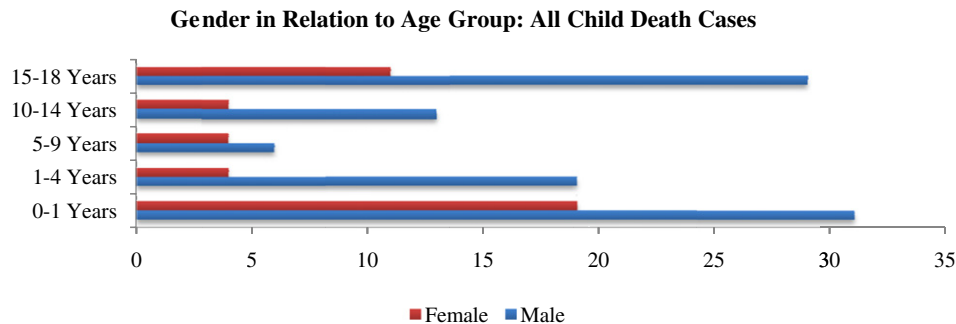


Fig. 3. Gender in relation to age groups: all child death cases.

deaths comprised all SIDS cases (21), all medical/disease related cases (18), and all stillborn and prematurity (3) (Table 2). When compared among age groups, the rate of vulnerability for natural deaths was highest for the 0–1 age group (54%), followed by the 5–9 age group (40%), the 1–4 age group (26%), then the 15–18 age group (10%), and the 10–14 age group (6%) shown in Table 3. Of the 42 natural deaths, the number of males was more than twice that of females (29 males versus 13 females) (Table 5).

Suicide (19 cases or 14% of all the deaths) ranked the third most leading manner of deaths. Suicide methods employed were (a), ligature hanging (14 cases), (b), gunfire (4), and (c), train collision (1) (Table 6). All the suicides were encountered in the older age groups 10–14 (6) and 15–18(13) (Table 7). Comparatively, homicide, which was found to be the least common manner of death (5%), was more predominant among the younger age groups (Table 9).

Homicide ranked the fourth common manner of deaths (Table 2). Homicide deaths were caused by blunt force trauma (4 cases), asphyxia by suffocation (1), sharp-force trauma (1), and child abuse (1), see Table 2.

When manner of death was evaluated for gender, males outnumbered females in accidents by 50 cases compared to 21, or a ratio of 2.4: 1. Both males and females were at higher risk of dying from accidents than from suicide, homicide or natural causes (Fig. 5 & Table 8).

Additionally, gender and age groups were compared for relationships (Table 9). The high rate of accidental deaths was found to

persist across all age groups. Both males and females in the 5–9 age group were more vulnerable to accidental deaths than deaths from homicide (0%) and suicide (0%). Children aged 10–14 and 15–18 years, especially males, were at greater risk of dying from suicide than homicide or natural causes. Males were observed in natural deaths more frequently than females in all age categories. In addition, while the rates of natural deaths and homicides were observed to decrease with age, the reverse was observed for suicide with a significant rise in the 10–14 age group, and increasing in the 15–18 age group.

5. Discussion

The objective of this retrospective review was to evaluate all the childhood deaths autopsied during a 7-year period (April 1, 2003 to March 31, 2010) at the Lancaster County Coroner's Office under the auspices of Nebraska Institute of Forensic Sciences, Inc. (NIFS) in Lincoln, Nebraska. The mean age of the victims was 7.6. The range of ages reported in this study was 0–18.

The racial and ethnic composition of Nebraska, according to the 2010 census was 86.1% white, 9.2% Hispanic or Latino, 4.5% African American, 1.0% American Indian and Alaska Native, and 1.8% Asian American. In 2009, persons under 18 years of age made up 25.1% of its population.⁵ Despite some small variations, our study population is largely consistent with the demographics of Nebraska with whites at 86.4%, Hispanics at 10.7%, American Indians at 0.7%, Asian Americans at 0.7%. There were only 2 African American

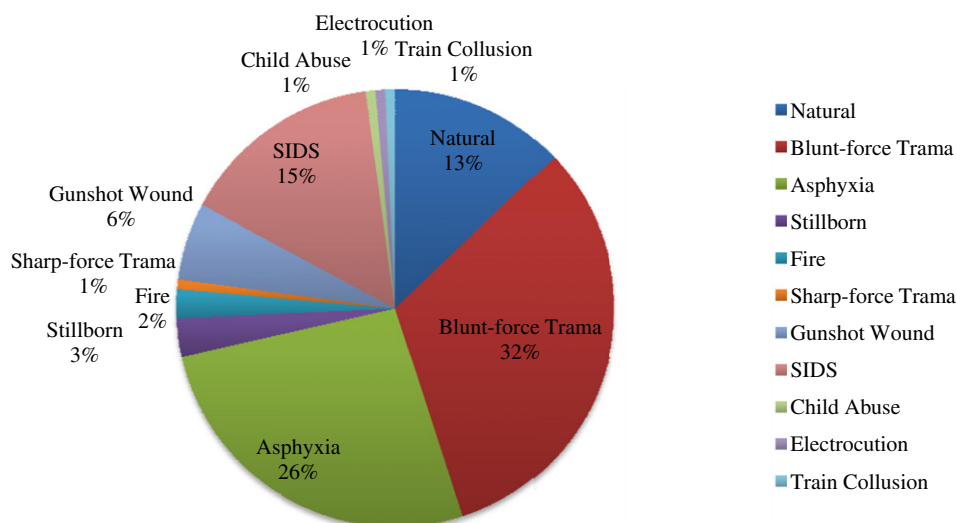


Fig. 4. Cause and manner of deaths: all death cases.

Table 2
Cause and manner of deaths.

	Accident	Homicide	Suicide	Natural	Undetermined	Total	Percent
Medical/Disease related				18		18	13
Blunt force trauma						45	32
Motorvehicle crash	33					33	
Other blunt force trauma	8	4				12	
Asphyxia						37	26
Hanging with ligature	1		14			15	
Asphyxia by overlaying	4					4	
Asphyxia by aspiration	1					1	
Asphyxia by suffocation	8	1			1	10	
Mechanical asphyxia due to drowning	7					7	
Stillborn/non trauma	1			3		4	3
Fire	3					3	2
Sharp-force trauma		1				1	1
Gunshot Wound	4		4			8	6
SIDS				21		21	15
Child Abuse		1				1	1
Electrocution	1					1	1
Train Collision			1			1	1
Total No, % of Manner	71(50.7%)	7(5%)	19(13.6%)	42(30%)	1(0.7%)	140(100%)	100.0%

victims in our study at 1.4% which was a decline from 4.5% for Nebraska. The limitations of this study are the small sample size and the homogenous demographics of the decedents as results may not be representative of similar studies in bigger urban populations. However, all the observations are consistent with the national and international forensic literature.

Gender gap in total childhood deaths was observed in this study. Male victims were more frequently encountered than female victims. This gap was most apparent among the 1–4 age group (Table 1) with a fatality rate of 83% for males compared to 17% for females. The overall male to female death ratio was 2.3 to 1. A higher burden of fatal accidents in males was observed with 50 (70.4%) males compared to 21 (29.6%) females. This male predominance in accidental death rates has been widely reported by several authors.^{6–8} One such example was a report by CDC examining patterns of accidental injuries among 0–19 year olds in the United States from 2000 to 2006. For each individual cause of death evaluated (drowning, falls, fires or burns, motor vehicle accidents, pedal cyclists, pedestrian accidents, poisoning, suffocation, transportation and other injuries), males had higher death rates compared to females. The highest rate for both males and females was among those with motor vehicle traffic occupant injuries (5.6 and 3.6 per 100,000, respectively). Male death rates measured three times higher for fall-related injuries and four times higher for pedal cyclists and other motor vehicle injuries than females.⁹ These findings probably reflect the impulsive nature and curiosity attributed to the male gender.¹⁰

In natural deaths (42 cases) which in this study are sub-categorized according to SIDS, all medical/disease-related illnesses, stillborn and prematurity, male predominance was also observed

with 29 (69%) males compared to 13 (31%) females. SIDS cases comprised 13 males and 8 females. Deaths resulting from natural illnesses and still born comprised 16 males and 5 females. Summary data are shown in Table 5. It is noteworthy that other authors have similarly considered male predominance in childhood deaths from all natural causes.¹¹ One case example was a study by the Tennessee Child Fatality Review Team. Upon reviewing each cause of death to Tennessee residents under age 17 from 1997 to 1999, they found that each year, more male children (55%) than female children (45%) died in every category of natural causes. Natural causes were categorized according to illness, prematurity and SIDS. In their study, more male infants (57%) than female infants (43%) died from SIDS, more male infants (54%) than female infants (46%) died from prematurity, and more male children than female children died from natural illnesses.¹¹ In explaining male predominance in natural deaths, Wells indicated that both morbidity and mortality are higher in males than in females in early life, with malnutrition and infection as the trigger, and males are severely more vulnerable to environmental stress than females.¹² The higher burden of male fatalities in SIDS as observed in our review (Table 5) has also been reported in the literature.^{11,13–15} However, the underlying causes of SIDS, including the phenomenon of male vulnerability for morbidity and mortality in early life are yet to be fully investigated and explained.

Accident remains a major public health threat for death and disability among growing children worldwide. As previously indicated, accident was the leading manner of death in this review which is consistent with many published statistics on childhood and adolescent deaths.^{6,8,16–21} Of the 140 cases in this study, the majority of childhood deaths occurred in the 0–1 age group with 50 (35.7%) cases. The 15–18 age group followed with 40 (28.6%) cases. The least number of deaths occurred in the 5–9 age group with 10 (7%) cases, as illustrated in Table 1. Accident was responsible for half of all the deaths in our study. This distribution is consistent with data reported in other studies. For example, the Hillsborough County, Florida Child Death Review Team (HCCDRT) reviewed a total of 233 child deaths that occurred between 1996 and 1998. The overall mean age at death was 6.8 years. The majority of deaths (34.8%) occurred in the age group classified as “under one year” followed by 28.8% of deaths in the 15–18 age group, with the least number of deaths (7.3%) occurring in the 5–9 age group, and accident was the most frequent cause of death.¹⁶

Table 3
Manner of death in relation to age groups.

Manner of Death	Age Group					Total
	0–1 Year	1–4 Years	5–9 Years	10–14 Years	15–18 Years	
Accident	18 (36%)	15 (65%)	6 (60%)	9 (56%)	23 (56%)	71
Homicide	4 (8%)	2 (9%)	0 (0%)	0 (0%)	1 (2%)	7
Suicide	0 (0%)	0 (0%)	0 (0%)	6 (38%)	13 (32%)	19
Natural	27 (54%)	6 (26%)	4 (40%)	1 (6%)	4 (10%)	42
Undetermined	1 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1
Total	50 (100%)	23 (100%)	10 (100%)	16 (100%)	41 (100%)	140

Table 4

Accidental deaths: age and sex distribution.

	0–1 Years		1–4 Years		5–9 Years		10 –14 Years		15 –18 Years		Total Male	Total Female	Total All
	M	F	M	F	M	F	M	F	M	F			
Motor Vehicle crashes	3	0	4	1	1	3	1	2	12	6	21	12	33 (46.5%)
Other blunt force trauma	2	2	0	0	0	1	1	1	1	0	4	4	8 (11.3%)
House Fire	0	0	2	0	1	0	0	0	0	0	3	0	3 (4.2%)
Still Birth/trauma	1	0	0	0	0	0	0	0	0	0	1	0	1 (1.4%)
Other Asphyxia													14 (19.7%)
Crib ligature	0	0	0	1	0	0	0	0	0	0	0	1	1
Overlaying	2	2	0	0	0	0	0	0	0	0	2	2	4
Aspiration	0	1	0	0	0	0	0	0	0	0	0	1	1
Suffocation	5	0	2	0	0	0	0	0	1	0	8	0	8
Drowning	0	0	3	1	0	0	1	0	2	0	6	1	7
Gunshot Wound	0	0	0	0	0	0	3	0	1	0	4	0	4 (5.6%)
Electrocution	0	0	1	0	0	0	0	0	0	0	1	0	1 (1.4%)
Total	13	5	12	3	2	4	6	3	17	6	50	21	71

In a study of children 0–3 years of age by Agran et al.,¹⁷ falls were reported as the leading cause of injury, followed by poisoning, transportation, foreign body, and fires/burns. Children aged 15–17 months had the highest overall injury rate, 94% higher than the rate for children aged 3–5 months coinciding with the stage of developmental achievements such as independent mobility, exploratory behavior, and hand-to-mouth activity. The child is able to gain access to hazards, but has not yet developed cognitive hazard awareness and avoidance skills.¹⁷ Reducing mortality rates in young children will require child-care education and injury-prevention services for parents and guardians, especially in high-risk families. Pediatricians and nurses are in a position to detect child abuse and neglect before fatal consequences occur. They can provide counseling and appropriate social services referrals.

Among the older children in our study, motor vehicle accident was the most common cause of accidental deaths, similar to those reported in other studies,^{7,9,21,22} many of which could have been avoided. There was not enough data in the autopsy log to fully characterize seat belt status for each case, but majority of the reported cases were not restrained. Toxicology reports (Table 10) revealed positive testing for alcohol and drugs in the majority of the victims, and this will be further discussed. Motor vehicle crashes are also reported as the leading cause of death among teenagers in the United States, accounting for more than one in three deaths in this age group, according to report from Centers for Disease Control. In 2009, eight teens ages 16 to 19 died every day from motor vehicle injuries. Per mile driven, teen drivers ages 16 to 19

are four times more likely than older drivers to crash.²³ While accident represented 71/140 (50.7%) of the total deaths in our study, motor vehicle crashes alone, comprised the most prevalent mechanism 33/71 (46.5%) of accidental injuries leading to death and constituted the largest share among all blunt force trauma deaths (Table 2). Male drivers are generally reported to be more involved in risky behaviors, thereby increasing the propensity for injury and death.²² It is no surprise that most of the motor-vehicle accidental deaths in our study occurred among the 15–18 age group (during the teenage driving age), and males predominated.

The death rate in Nebraska roadways in 2009 was 1.2 persons killed per 100 million vehicle miles traveled. Although fatalities increased from the record-breaking low year of 2008, the 223 fatalities recorded during 2009 were still the lowest in history, according to the State of Nebraska 2009 Traffic Crash Fact Annual Report.²⁴ This report is very encouraging and shows that the current regulations on graduated driver licensing, seatbelt laws, and child seat restraint policy are actively enforced. Nebraska has effective rules to keep risky drivers out of the road, in addition to stringent educational programs and a zero tolerance policy on drugs and alcohol. However, the state and federal agencies must continue to reinforce existing policies and develop age-specific targeted strategies aimed at reducing traffic-related deaths among teenage drivers.

The role of alcohol and other drugs in impairing driving ability is well documented in the literature. Impairment increases as the level of blood alcohol or other drug rises.²⁵ Due to the fact that

Table 5

Natural deaths: SIDS, Medical/disease-related deaths& stillborn.

Cause of death	0–1 Years		1–4 Years		5–9 Years		10–14 Years		15–18 Years		Total	
	M	F	M	F	M	F	M	F	M	F	M	F
SIDS	12	8	1	0	0	0	0	0	0	0	13	8
Medical/Disease Cases												
Seizures	0	0	1	0	0	0	0	0	1	0	2	0
Cardiovascular	1	0	0	0	1	0	1	0	2	0	5	0
Pulmonary	2	1	2	0	0	0	0	0	0	0	4	1
Gastrointestinal	0	0	0	0	1	0	0	0	0	0	1	0
Malignancy	0	0	0	0	1	0	0	0	0	0	1	0
Genetic defect	0	1	0	0	0	0	0	0	0	0	0	1
Brain Defect	0	0	1	0	1	0	0	0	0	1	2	1
Stillborn	1	2	0	0	0	0	0	0	0	0	1	2
Total	16	12	5	0	4	0	1	0	3	1	29	13
Total	28		5		4		1		4		42	

Table 6
Suicide cases.

Method of Suicide	n	Percent
Hanging with ligature	14	73.7
Gunshot wound	4	21
Train collision	1	5.3
Total	19	100

a fatal motor accident from toxicological causes may not be readily apparent, suspicion must be maintained. For this reason, a complete toxicological screen is always performed for all medico-legal death investigations to identify the presence or absence of drugs and toxic substances, and how much is present. The minimum age in Nebraska to receive a provisional operator's permit to drive a vehicle is 16 years. Toxicology reports of motor vehicle accident victims 16–18 years of age in our study were therefore reviewed. There were 14 decedents identified in this age group, 9 were drivers and 5 were passengers. Six decedents were identified whose cause of death was toxicological. Alcohol was involved in 3 deaths; difluoroethane was involved in 1 death, Morphine was involved in 1 death, and methamphetamine was involved in 1 death (Table 10). Drugs detected at autopsy may reveal the presence and consumption of new drugs and any major changes or trends among children and adolescents that may lead to deaths. Such information will guide policymakers in developing programs and educational interventions aimed at controlling trafficking of such drugs and thereby reducing negative consequences. It will also be useful for emergency room physicians, first responders and law enforcement in their daily encounters with this age group.

Families are devastated when a loved child is tragically dead in an accidental drowning. Out of 7 drowning deaths in this review, 6 were males and 1 was female. The majority of the deaths occurred in the 1–4 age group 4/7 (57%). The remaining 3 deaths were found in the 10–14 age group 1/7 (14.3%), and the 15–18 age group 2/7 (28.6%). Of the total 7 drowning deaths, 3 were Hispanics and 4 were whites. All the drowning occurred in separate incidents. Among the total deaths in the study, Hispanics make up only 10.7%. Therefore, the drowning death rate among Hispanics (43%) from this data appears disproportionate. Future investigation will show whether this is a growing trend or a chance occurrence, considering the small number (7) of the total drowning deaths.

All the Drowning incidents were accidental and occurred in the pool, camp, and in the lake. Toxicology reports showed no evidence of drug or alcohol in the decedents' blood. None of the drowning deaths occurred in bathtubs. As a routine, all drowning cases require a detailed history, scene investigation, and autopsy to rule out drug and alcohol use, or evidence of foul play. Based on investigative reports and analysis of the drowning accidents, the drowning deaths could have been prevented by efficient parental or other adult supervision, securing pools with safety barriers and locks, as well as proper use of safety vests for children while

Table 8
Manner of death in relation to gender.

Manner	Male	Female
Accident	50 (51%)	21 (50%)
Homicide	4 (4%)	3 (7%)
Suicide	14 (14%)	5 (12%)
Natural	29 (30%)	13 (31%)
Undetermined	1 (1%)	0 (0%)
Total	98 (100%)	42 (100%)

swimming. In addition, teenagers should refrain from drinking alcohol before or during swimming, and adults should avoid drinking alcohol while supervising children. Formal swimming lessons can protect young children from drowning. Knowledge of cardiopulmonary resuscitation (CPR) by parents and pool supervisors is important because it can be a critical life-saving intervention if started early by any bystander while waiting for paramedics to arrive at the scene.

Burns and scalds are also significant in childhood home injuries. Without adequate supervision, small children are vulnerable to house fire injuries and deaths, scalds from hot water, and severe burns from hot oil and chemicals. Children are very active and curious by nature, and they want to explore everything around them. Three cases of house fires in this study involved a 7-year old male, a 4 1/2-year old male, and a 2-year old male. Although not a leading cause of accidental deaths for any of the reported age groups, emphasis on fire safety and preventive measures, such as proper adult supervision and smoke detective devices both in the homes and in all child care centers are very crucial in preventing unnecessary injuries and deaths. Adults must refrain from smoking around children because children learn by imitation and may want to play with matches and lighters if left within their reach.

Asphyxia death in a child, especially when it happens suddenly and unexpectedly can be severely traumatic to the family. In this study, 8 infants died accidentally due to asphyxia by suffocation, and 4 infants suffocated due to overlay. Many studies have been conducted about infant sleeping environments that may be linked with the risk of asphyxia and sudden death.²⁶ Reports from these studies have led to formulations of safety recommendations. By nature, children are curious and can move around in the crib and try to grab things within their reach. Parents and caregivers must be clearly informed to secure cribs firmly against the wall, avoid potentially dangerous articles such as cords, clothing, toys with long strings, and hanging objects inside or around cribs to prevent children from accidentally hanging themselves. The importance of using cribs and mattresses with the appropriate design and standards cannot be overstressed.

Bed sharing by parent(s) or other adult with an infant on the bed or couch/sofa is dangerous due to risk of accidental suffocation. Accidental suffocation can occur either due to overlay or entrapment/wedging between the back of sofa and the co sleeper.²⁶ Overlaying, the accidental death by smothering caused by a larger

Table 7
Suicides by Mode/Mechanism, age and sex distribution.

Mode/Mechanism	0–9Years		10–14Years		15–18Years		Total M	Total F	Total
	M	F	M	F	M	F			
Hanging with ligature	0	0	4	0	7	3	11	3	14
Gunshotwound	0	0	1	1	2	0	3	1	4
Train collision	0	0	0	0	0	1	0	1	1
Total	0	0	5	1	9	4	14	5	19
Total	0	0	6		13		19		19

Table 9

Manner of death in relation to gender and age group.

Manner of death	0–1 Years		1–4 Years		5–9 Years		10–14 Years		15–18 Years		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
Accident	13 (42%)	5 (2%)	12 (63%)	3 (75%)	2 (33%)	4 (100%)	6 (50%)	3 (75%)	17 (57%)	6 (55%)	71 (50.7%)
Homicide	2 (7%)	2 (11%)	1 (3%)	1 (25%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	7 (5%)
Suicide	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (42%)	1 (25%)	9 (30%)	4 (36%)	19 (13.6%)
Natural	15 (48%)	12 (63%)	6 (32%)	0 (0%)	4 (67%)	0 (0%)	1 (8%)	0 (0%)	3 (10%)	1 (9%)	42 (30%)
Undetermined	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0.7%)
Total	31	19	19	4	6	4	12	4	30	11	140

individual sleeping on top of an infant has been reported to be greater in infants less than 5 months of age, but may occur in children up to the age of 2 years.²⁷

In the natural death category, the medical/disease-related cases included seizures, broncho-pneumonia, cardiovascular diseases, laryngo-tracheal bronchitis, bronchial asthma, gastro-enteritis, mental retardation, respiratory distress, genetic defect and brain defect. Natural deaths accounted for the second most common manner of death overall, and were more predominantly observed in the younger age groups. However, with increasing age, children's risks of dying from natural deaths decreased while unintentional injuries and violent manner of death categories, such as motor accidents and suicides became more significant (Table 3), apparently as a result of increased mobility, independence and outdoor activity.

Beckwith defined SIDS as the sudden and unexpected death of an infant younger than one year and usually beyond the immediate perinatal period, which remains unexplained after a thorough case investigation, including performance of a complete autopsy and review of the circumstances of death and of the clinical history. Onset of the lethal episode was presumably during sleep (i.e., the infant was not known to be awake). Minor inflammatory infiltrates or other abnormalities insufficient to explain the death are acceptable.²⁸ Death rates from SIDS have been reported to have declined in the United States by 40% over the past few years since the recommendations by the American Academy of Pediatrics²⁹ and the National Back to Sleep Campaign³⁰ advocating for the avoidance of infant prone position when sleeping. The adverse consequences of maternal cigarette smoking and covering of baby's head with beddings have also been documented in relation to SIDS.³¹

Stillbirths and prematurity comprised only 3 of the natural deaths. While the medical and physiological factors underlying the gestational problems and premature births are beyond the scope of this paper, preventive and public health efforts can educate and advise parents about early prenatal care, avoidance of alcohol and drugs, good diet, and reducing teen pregnancies.

Suicides comprised (19) 13.6% of the 140 childhood deaths during this review period. It has been reported that when pressures of life seem too much to cope with, some teenagers look at suicide as a welcome escape.³² Male children were disproportionately represented among the suicide victims as reported in other studies.^{8,18,33} Males are three times more likely than females to complete suicide, but females are more likely to exhibit persistent suicidal ideation and to engage in self-injury or self-harm behavior, without expressed intent to die.⁸ In this study, suicide (19 cases) was the third leading cause of death and was only found in the older age groups. Other authors also found suicide as the third leading cause of death in their studies^{18,21,34} The rates increased significantly as the children advanced in years from 10 to 14 age group (6 suicides) to 15–18 age group (13 suicides). Suicide methods were hanging with ligature, 14/19 (73.7%), gunshot wound 4/19 (21%), and train collision 1/19 (5.3%) as illustrated in Table 6. Of these 14 ligature hangings, 11 were males, and 3 were females (Table 7).

Suicide prevention strategies must focus on a number of interventions. Parents and teachers must pay closer attention to children who are showing signs of anxiety, depression, change in behavior, or being bullied. Counseling services should be made available in schools for children who are experiencing emotional or psychological problems. When children are experiencing stress, depression or mental illness, guns in the home may be a potential

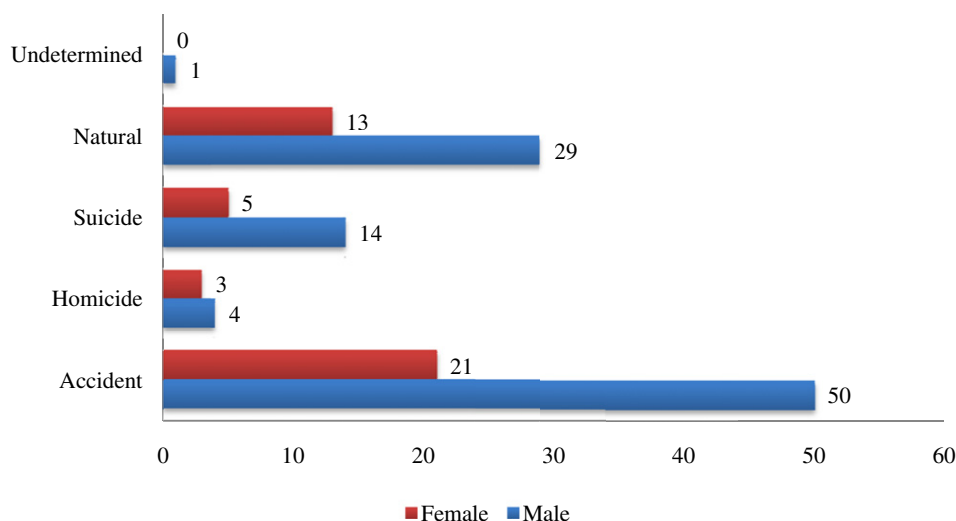
**Fig. 5.** Manner of death in relation to gender.

Table 10

Toxicological reports in motor vehicle accidental deaths: 16–18 year age group.

Cases	Age	Sex	Race	Driver or passenger	Toxicology reports
1	17	M	w	Driver	Negative
2	17	M	w	Driver	Blood Alcohol .160 gm%
3	16	M	w	Driver	Negative
4	17	M	w	Passenger	Methamphetamine 0.32 mcg/ml
5	18	M	w	Passenger	Blood Alcohol 0.128 gm%
6	18	F	w	Driver	Negative
7	17	M	w	Driver	Morphine 0.057 mcg/ml
8	18	F	w	Passenger	Negative
9	17	M	w	Driver	Negative
10	16	M	w	Driver	Diffuoroethane 44.3 mcg/ml
11	18	F	w	Driver	Negative
12	17	F	H	Passenger	Negative
13	18	M	w	Driver	Blood Alcohol .223 gm%
14	17	M	w	Passenger	Negative

risk for suicide. Restriction policies on hand gun availability and accessibility to children in the home and restrictions on alcohol use among teenagers will help in reducing child suicide.

Homicides are tragic misadventures especially when the victim is a young child or an adolescent. Homicide 7 cases (5%) was the least common manner of death in this study. All but one of the homicidal victims were very young, below 4 years of age. One case was in the 15–18 age group. No homicidal death was found in the 5–9 age group. The most common mechanism was blunt force trauma 4/7 (57%), asphyxia by suffocation 1/7 (14.3%), sharp-force trauma 1/7 (14.3%) and child abuse 1/7 (14.3%). Of the homicides, 4 were found to be less than 1 year old, 2 were found in the 1–4 age group, and the last one was found in the 15–18 age group. Homicide in young children is very unfortunate because the home, daycare or school is intended to be a child's caring and trusting environment for safety and support.

In the last five years, 21 children in Nebraska have been killed directly because of child abuse or in some cases linked to potential abuse or neglect – 0 of them in 2003.³⁵ Fujiwara, Barber, & Hemenway³⁶ reported in their study that in most cases, the homicide occurs at home with the perpetrator being a family member or caretaker. Indeed, a young child is more likely to be murdered by the mother's boyfriend than by all acquaintances and strangers combined. In the majority of cases, the murdered children are killed by the perpetrator's hands (beating, shaking, or choking).

Young children must be protected from becoming victims of homicide, abuse or neglect. The law enforcement has established protocols for providing a faster response in child abduction situation. Efforts are in place concerned with juvenile health and welfare issues. Nebraska has a Child Death Review Team that reviews suspicious deaths of children, identify possible homicides and recommend prevention strategies. It is hoped that increased scrutiny of all childhood deaths will lead to a better understanding of factors that led to these deaths.

Although no gun fires were used in any of the homicides, existing laws designed to limit children's access to guns in the home must be strongly enforced to guard against future loss of lives. Nebraska has several laws related to the acquisition, sale and storage of guns. Gun owners must store their guns in a locked safe, unloaded. Certain types of guns and ammunition are not allowed for public use. Gun registration and licensing are required of all gun owners.

6. Conclusion

Accident and suicide were respectively the first and third leading manners of death, most of which could have been prevented by certain precautions and interventions. Natural death, the second leading manner of death could have been reduced as well.

The majority of all the victims of accident and suicide were males and in the older age groups. Six homicide cases out of the seven were less than 5 years old. The perpetrator was likely a family member or a familiar person. Hanging was the suicide method used by the majority of the decedents which was in contrast to the reported trend among teenagers in the national and state data.

The loss of a child just starting out in life can be very tragic and heart wrenching to loving family and friends. The prevention and reduction of unnecessary deaths, along with finding the causes and manner of deaths, are some of the state's public health concerns. A complete and thorough forensic investigation of death is not only important for the legal, the medical, the scientific community and the public, it is what the family and friends need to make sense of what happened and find closure.

Reducing childhood deaths in Nebraska will require a combined effort on the state, local and community level. Much of the declining rate of childhood injury, crime and illnesses so far accomplished are credited to the legislative enforcement, educational efforts, public health initiatives, social services interventions, and organized community networks. All these programs working along with the multidisciplinary Child Death Review Team assess the causes, preventability and epidemiology of deaths, including a systematic population-based data and recommendations for prevention. Continuous efforts must be maintained with those targeted strategies. Age-specific programs to decrease road traffic accidents, child homicides, suicides and hanging among older children must be developed and implemented to reduce deaths from these causes. Educational outreach programs targeted to children and adolescents should be sustained, and health messages should reinforce what is learned in school. These messages must address issues such as, the use of safety belts, anger management and peer pressure, driving when impaired from drugs or alcohol, illegal use of guns, gangs and bullying.

Conflict of interest

The authors have no conflict of interest. They have no controlling interests in the Journal of Forensic and Legal Medicine.

Funding

None.

Ethical approval

None.

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